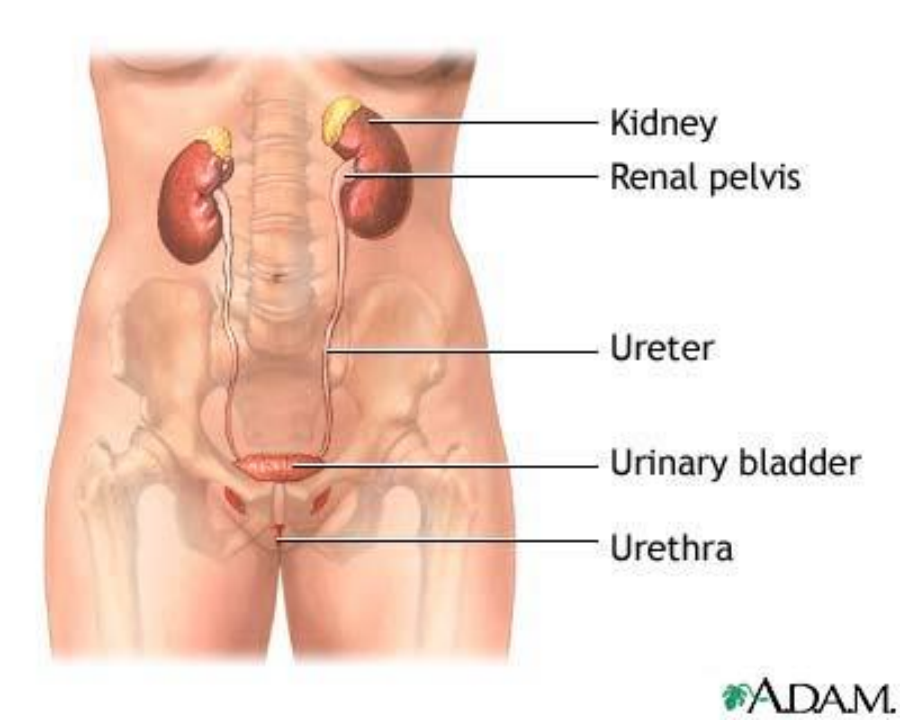
Ch 24: Urinary System



Objectives

Identify and describe the components of the urinary system and their function

Describe the (histological) organization of the nephron

Identify the blood vessels that supply blood to the nephrons

Describe the blood flow through and around the nephron

Trace a drop of filtrate as it becomes urine

Developed by
John Gallagher, MS, DVM

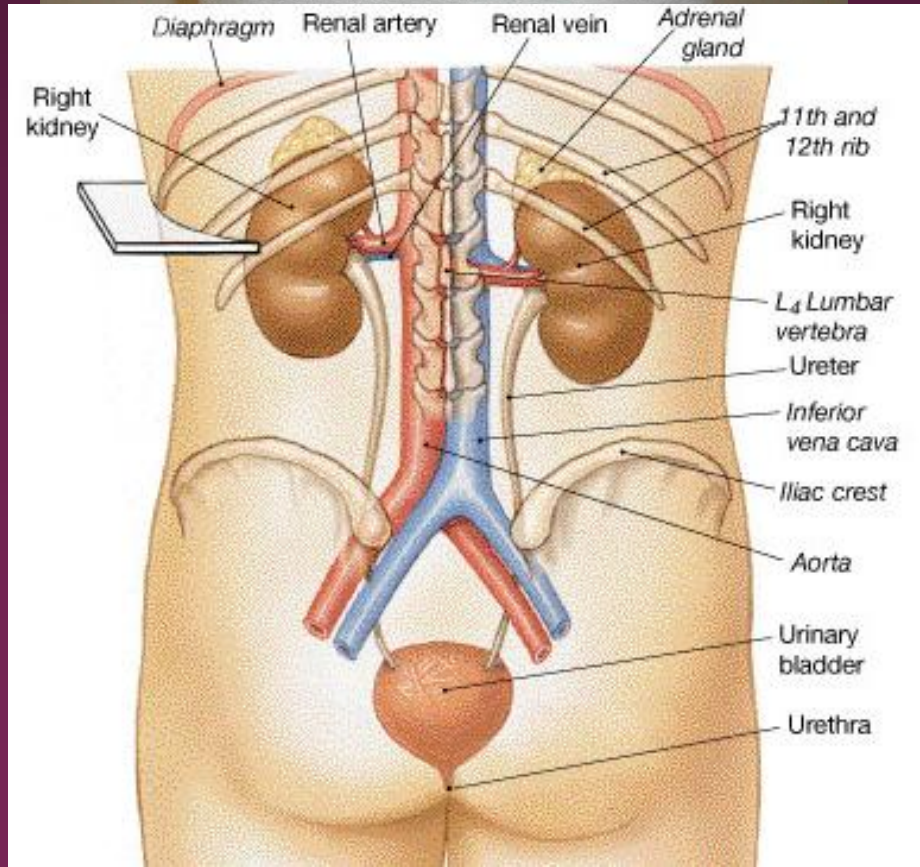
LAS POSITAS COLLEGE

Functions of Urinary System (Kidneys):

- Regulate fluid balance (fluid volume) of the body
- Excrete organic waste products and conserve nutrients, etc
- Stabilize pH
- Regulate electrolyte concentrations in the blood
- Endocrine functions

Kidney Location

- **Lateral to vertebral column high on body wall, under floating ribs, in retroperitoneal position (posterior to the parietal peritoneum)**
- **The right kidney is slightly inferior to the left kidney in order to accommodate the liver**
- **Surrounded by the renal capsule with a fat pad**
- 12 x 6 x 3 cm
  - Bean shaped
  - **Hilus** – indentation

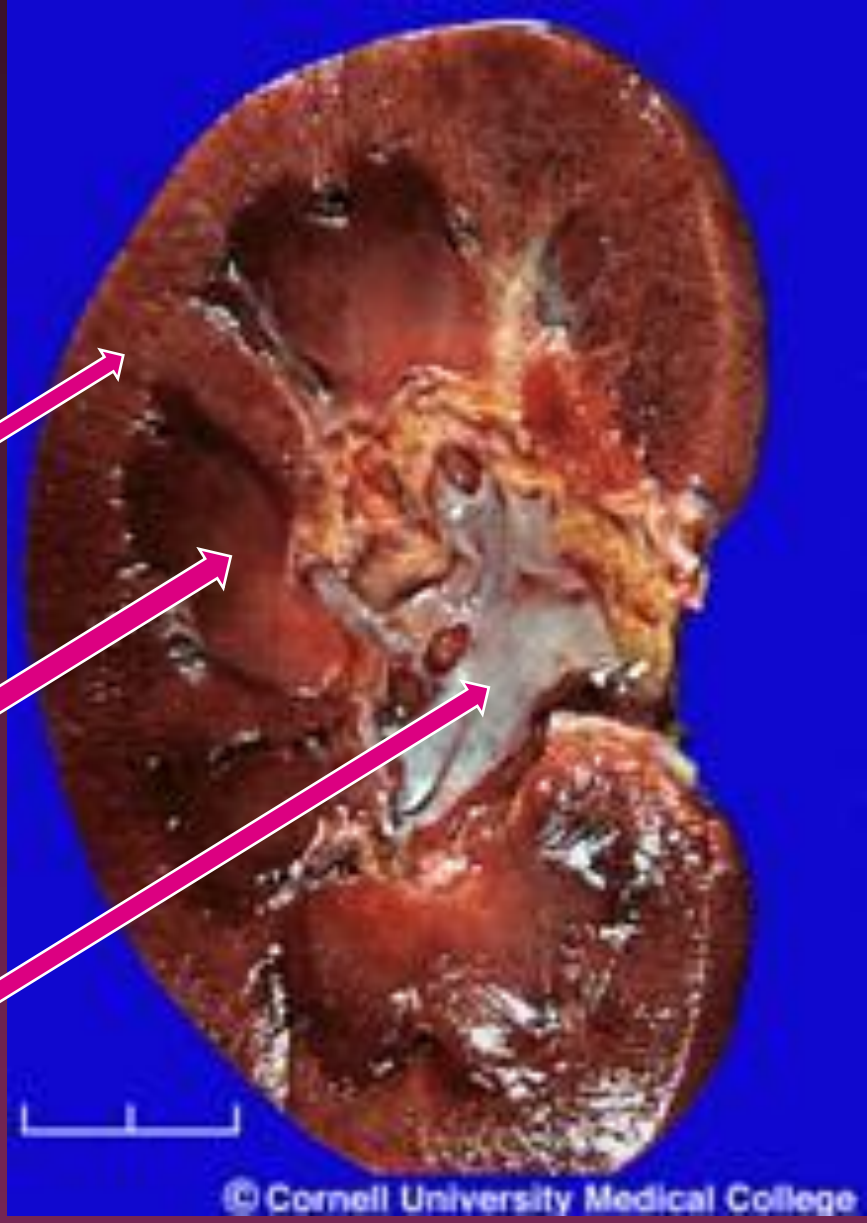


Internal Anatomy

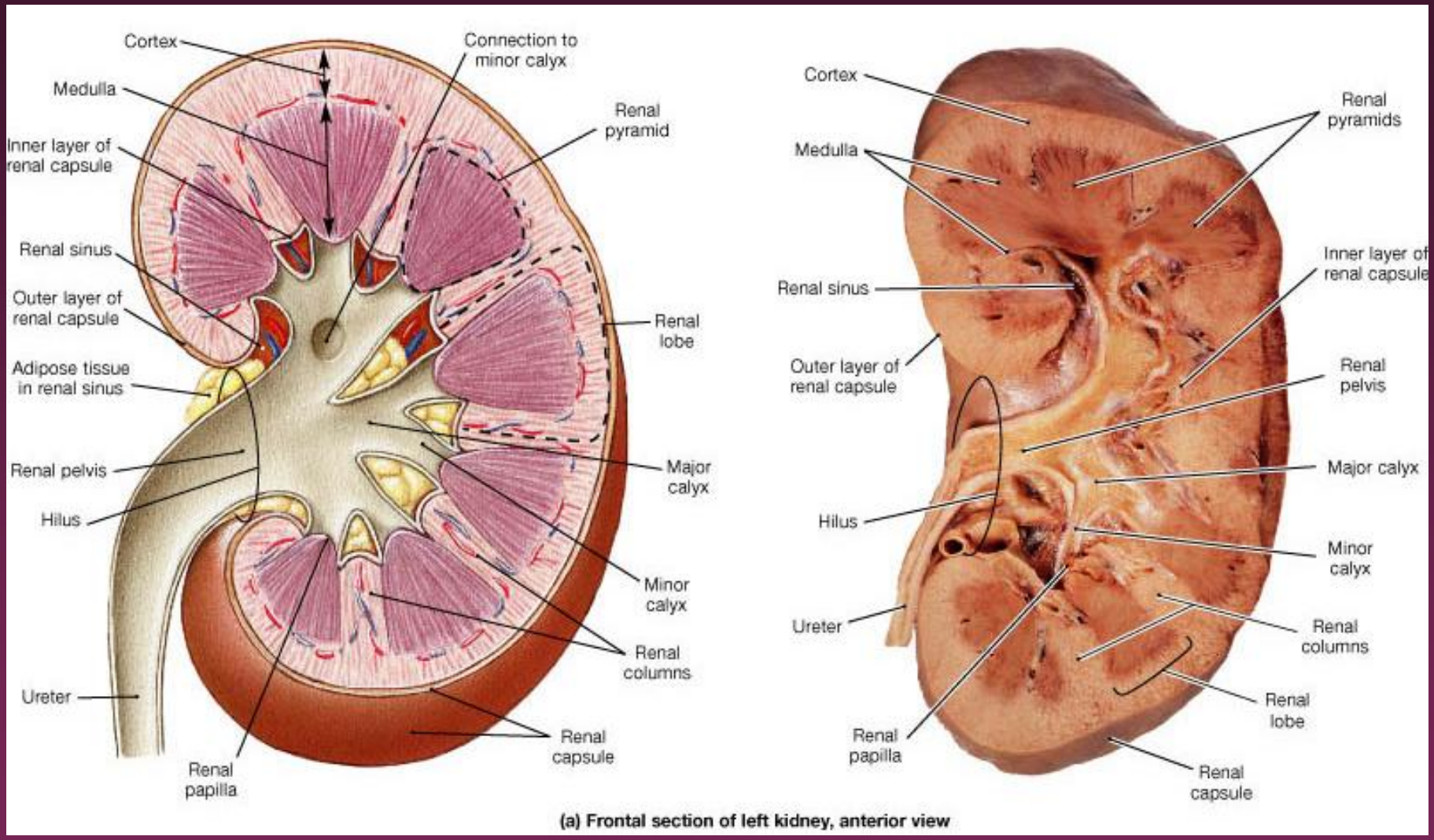
Cortex: outer layer, light reddish brown, granular appearance (due to many corpuscles)

Medulla: darker striped appearance (due to tubules) Subdivided into distinct renal pyramids, terminating with a papilla. Separated by renal columns from the cortex.

Pelvis: Expanded proximal ureter



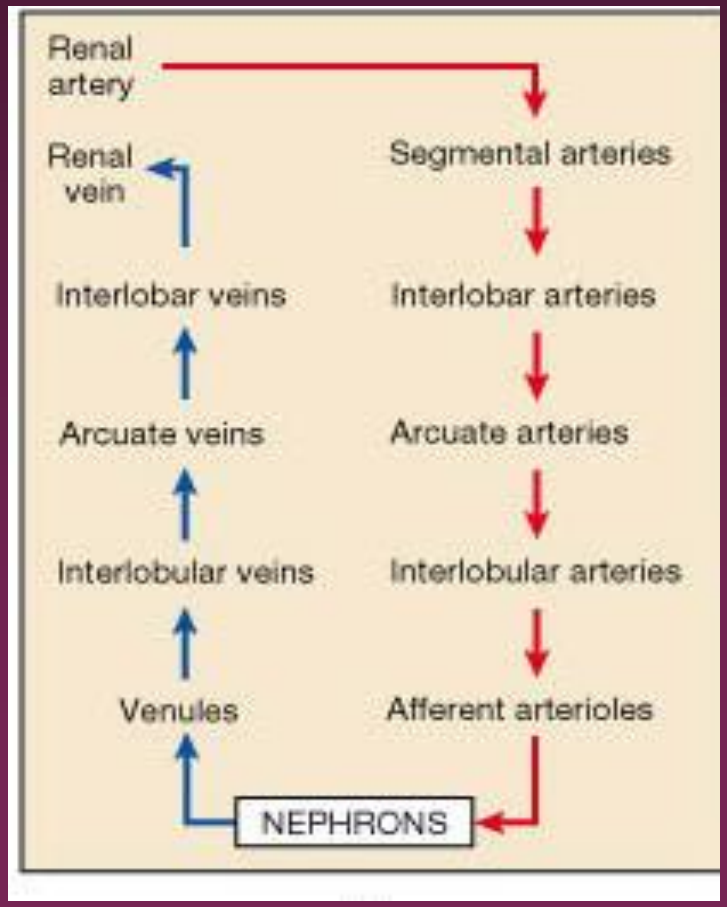
Compare to Fig 23.3

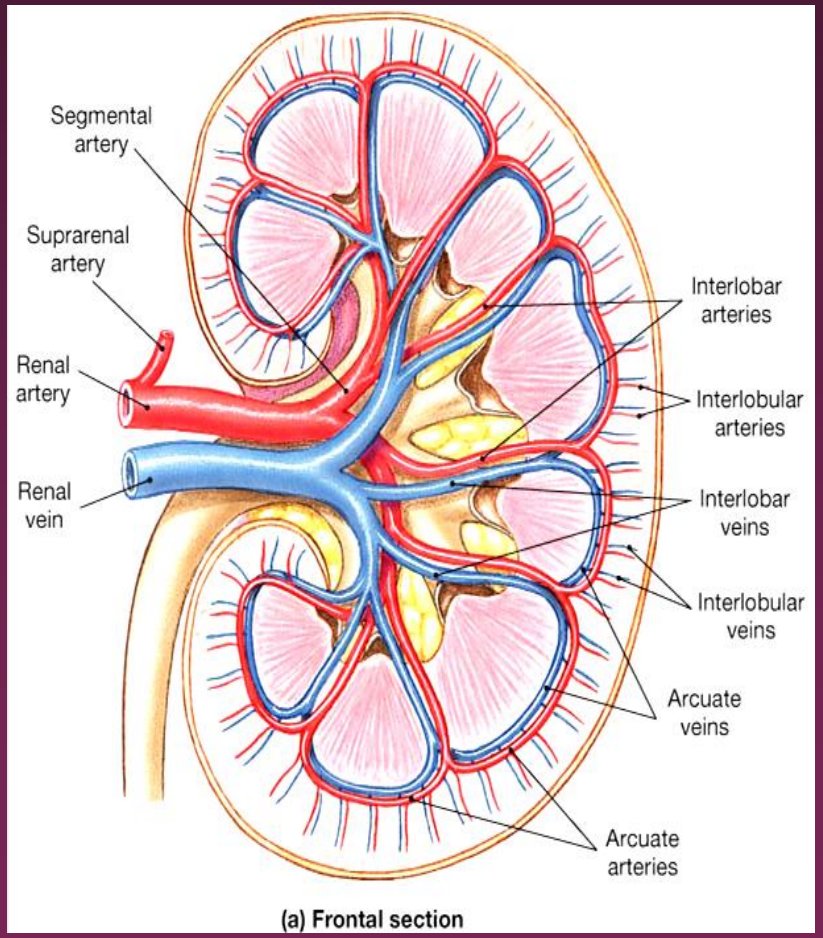


(a) Frontal section of left kidney, anterior view

Renal Circulation

20-25% of cardiac output!!



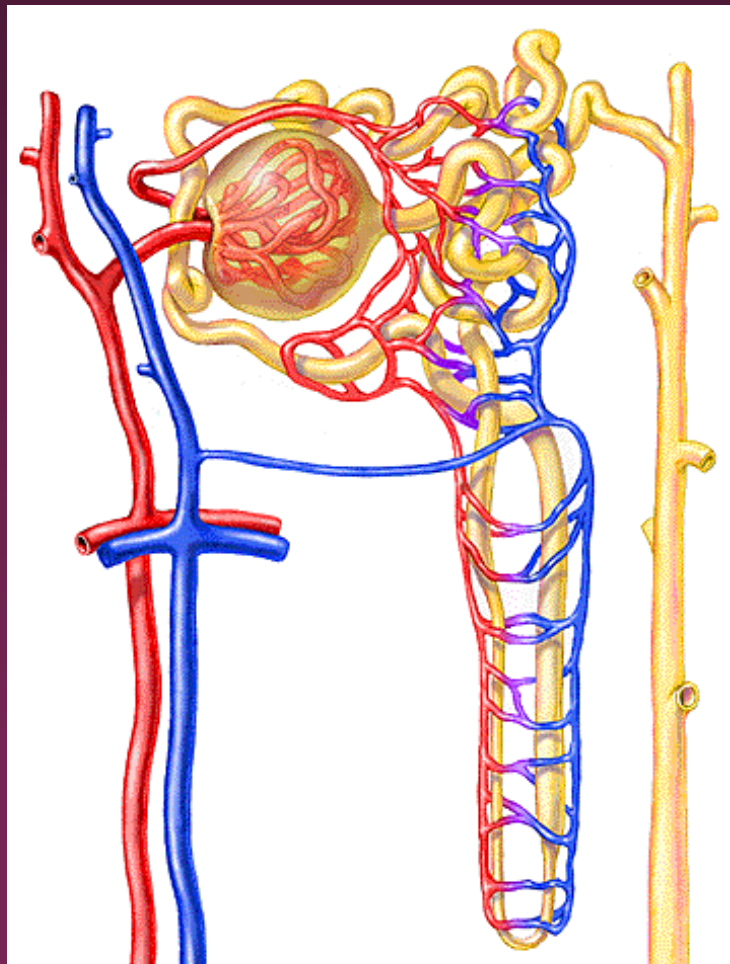


R
L

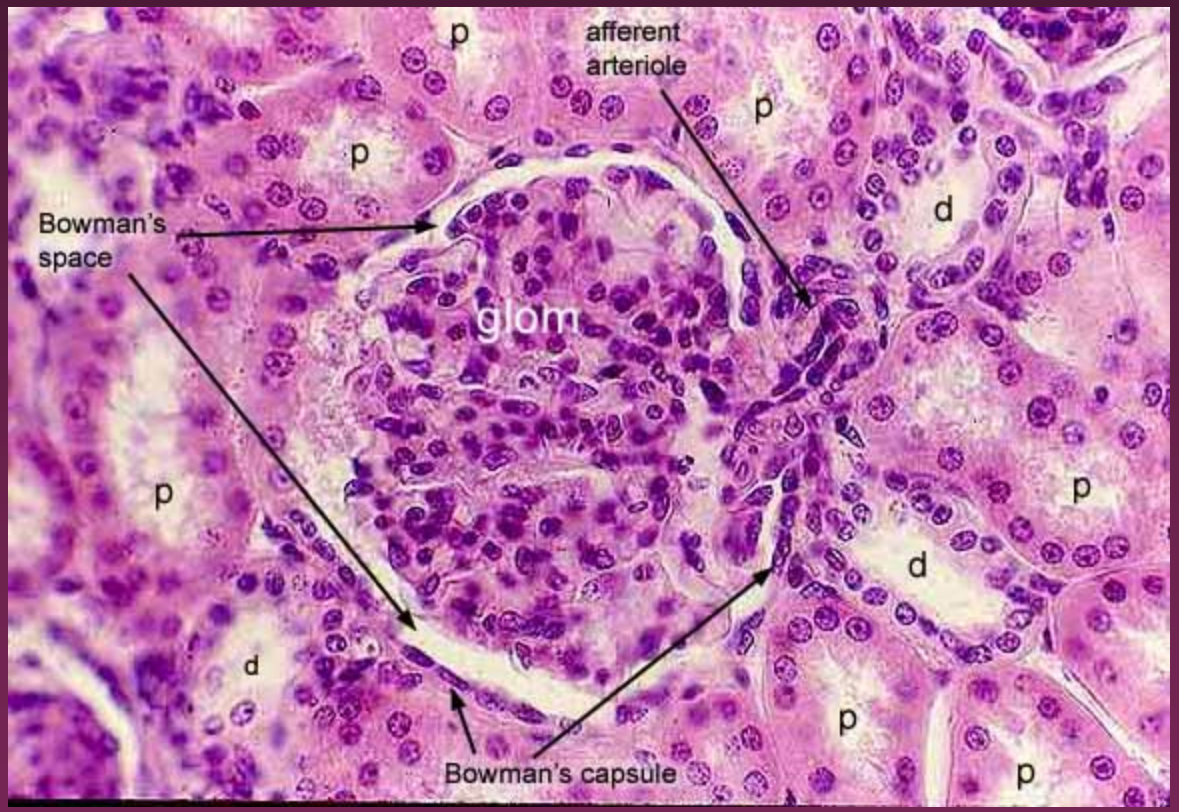
Nephron = functional unit (p712)

(>10^6/kidney)

- Nephron =
  1. Renal Corpuscle
     1. Glomerulus
     2. Bowman's (Renal) Capsule
  2. PCT (proximal convoluted tubule)
  3. LOH (loop of Henle)
  4. DCT (distal convoluted tubule)
  5. Collecting duct



Renal Corpuscle

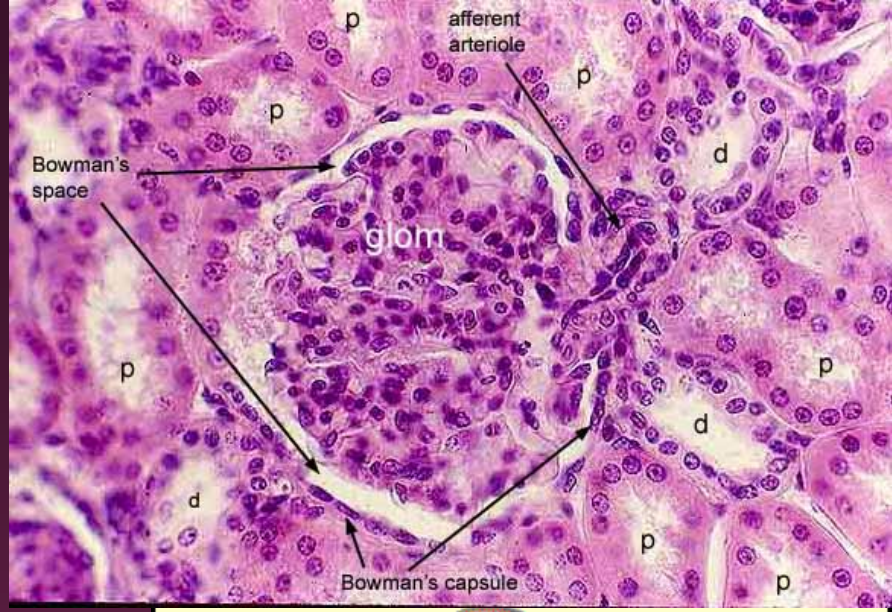


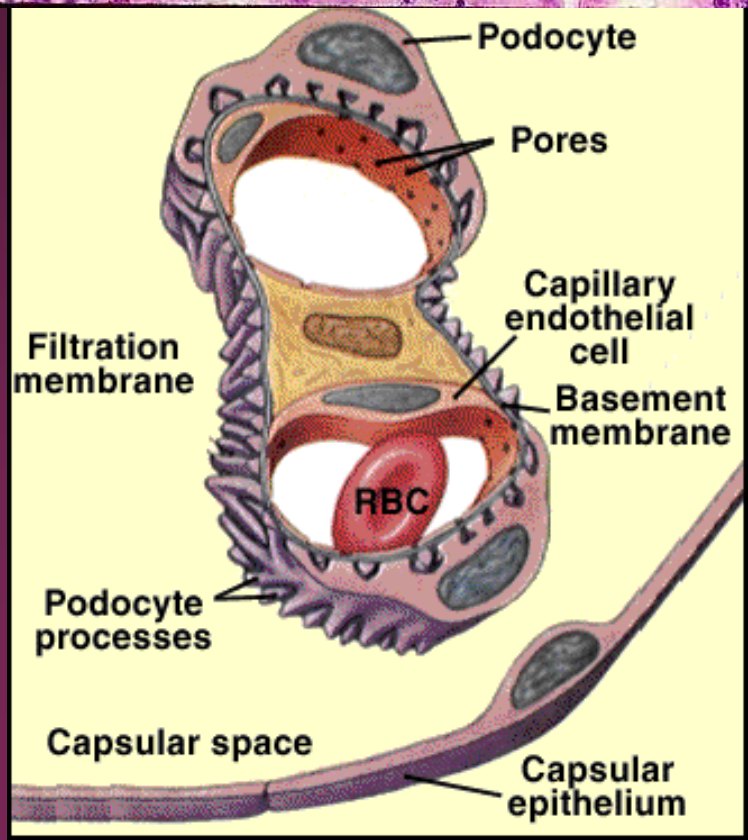
The Renal Corpuscle

Filtration: Passage across three barriers

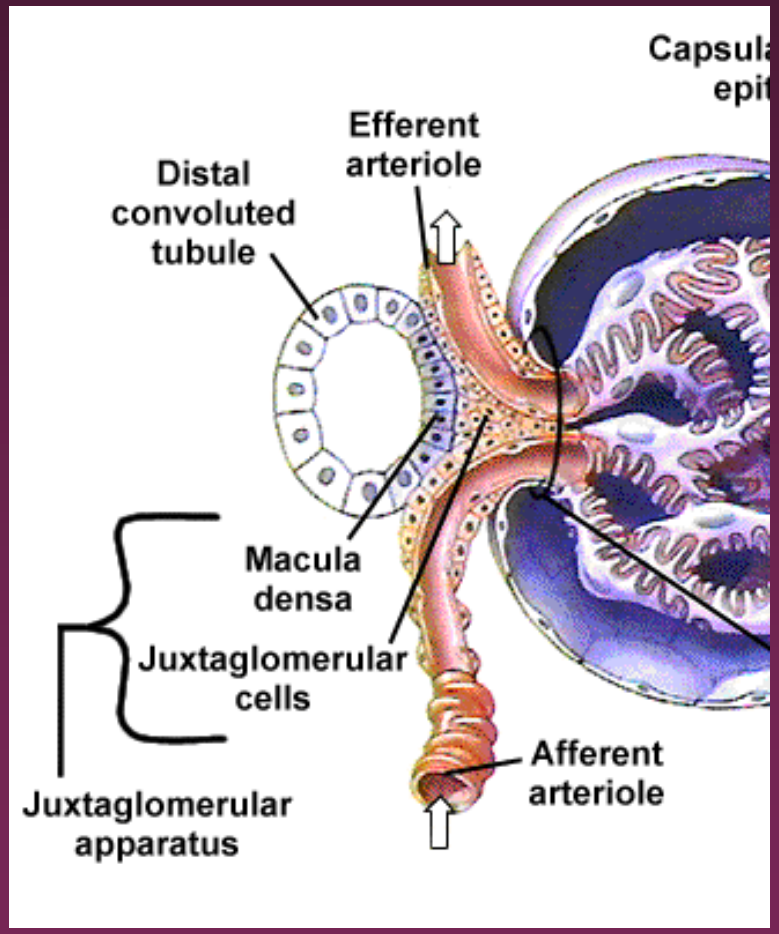
1. Capillary endothelium
   - Fenestrated
   - What gets through?
2. Basement membrane
3. Glomerular epithelium (= visceral layer of Bowman's capsule)
   - slit pores between pedicles of podocytes

Note: Capsular Epithelium is simple squamous epithelium





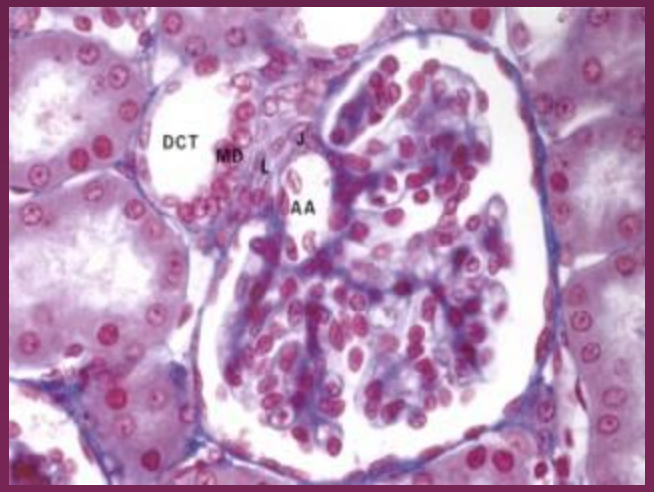
Juxtaglomerular (JG) Apparatus



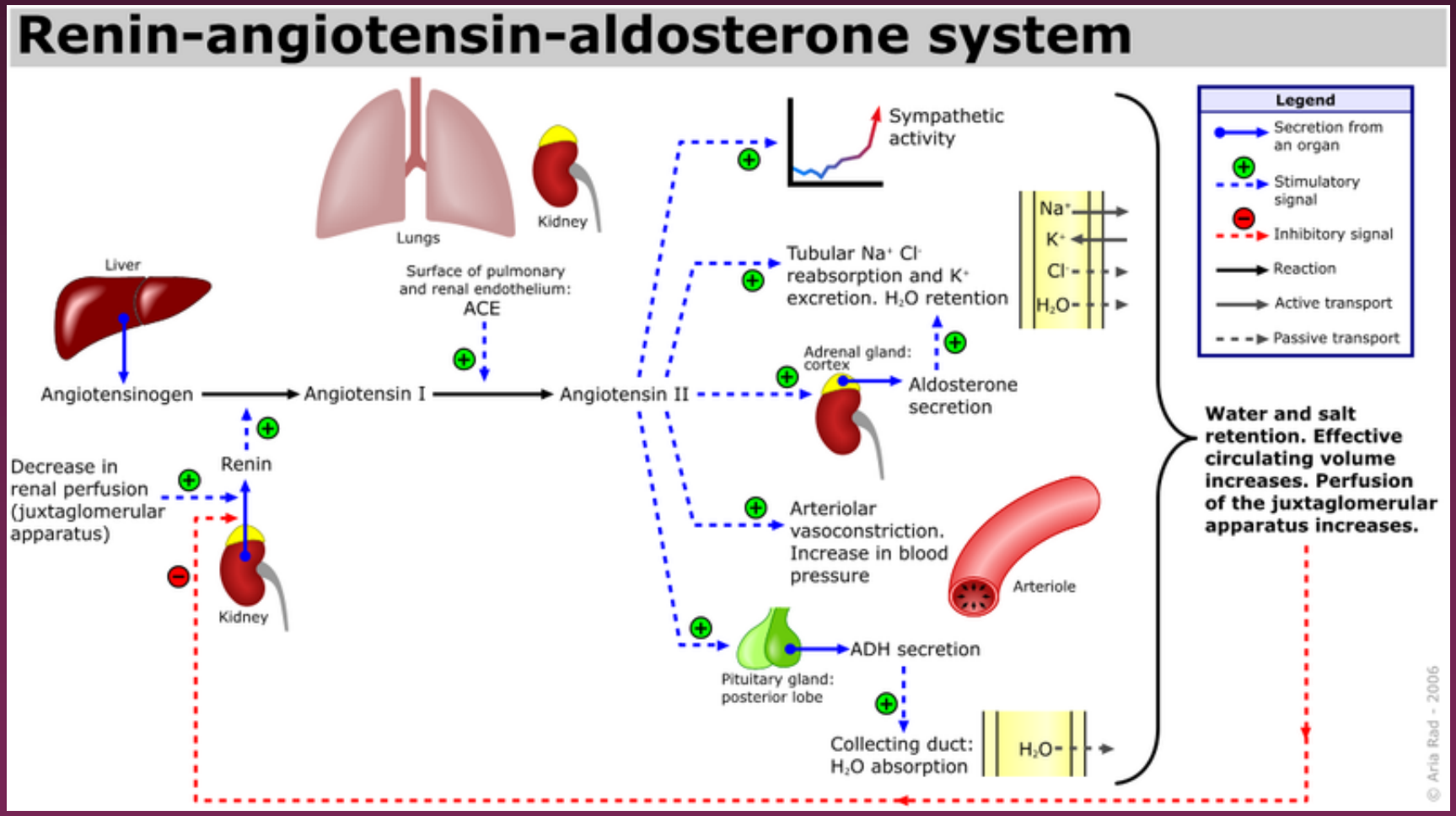
Juxtaglomerular Apparatus = Macula densa + Juxtaglomerular cells (smooth muscle fibers from afferent arteriole)

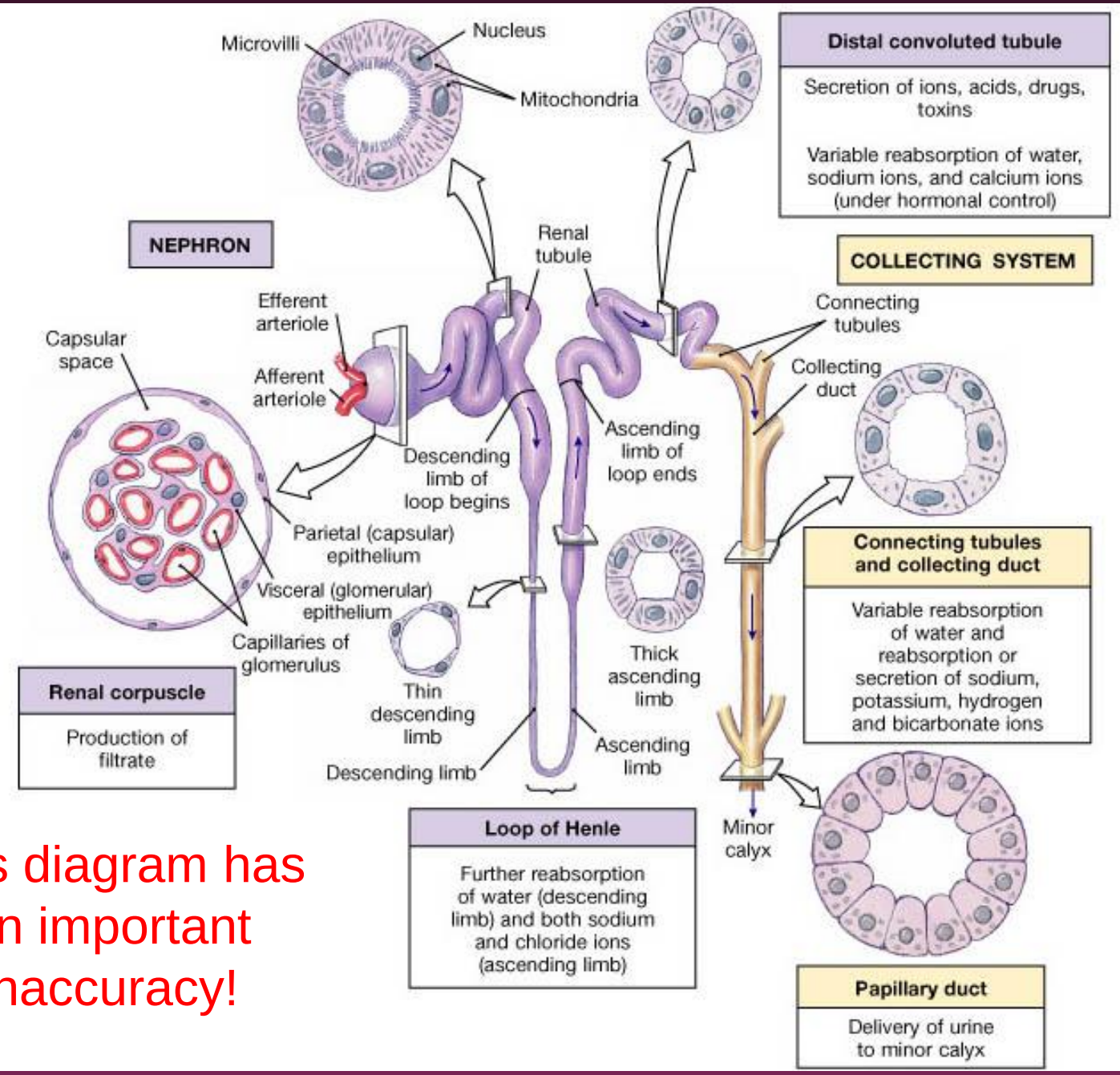
Macula densa monitors NaCl and flow through the DCT

JG cells produce renin and EPO

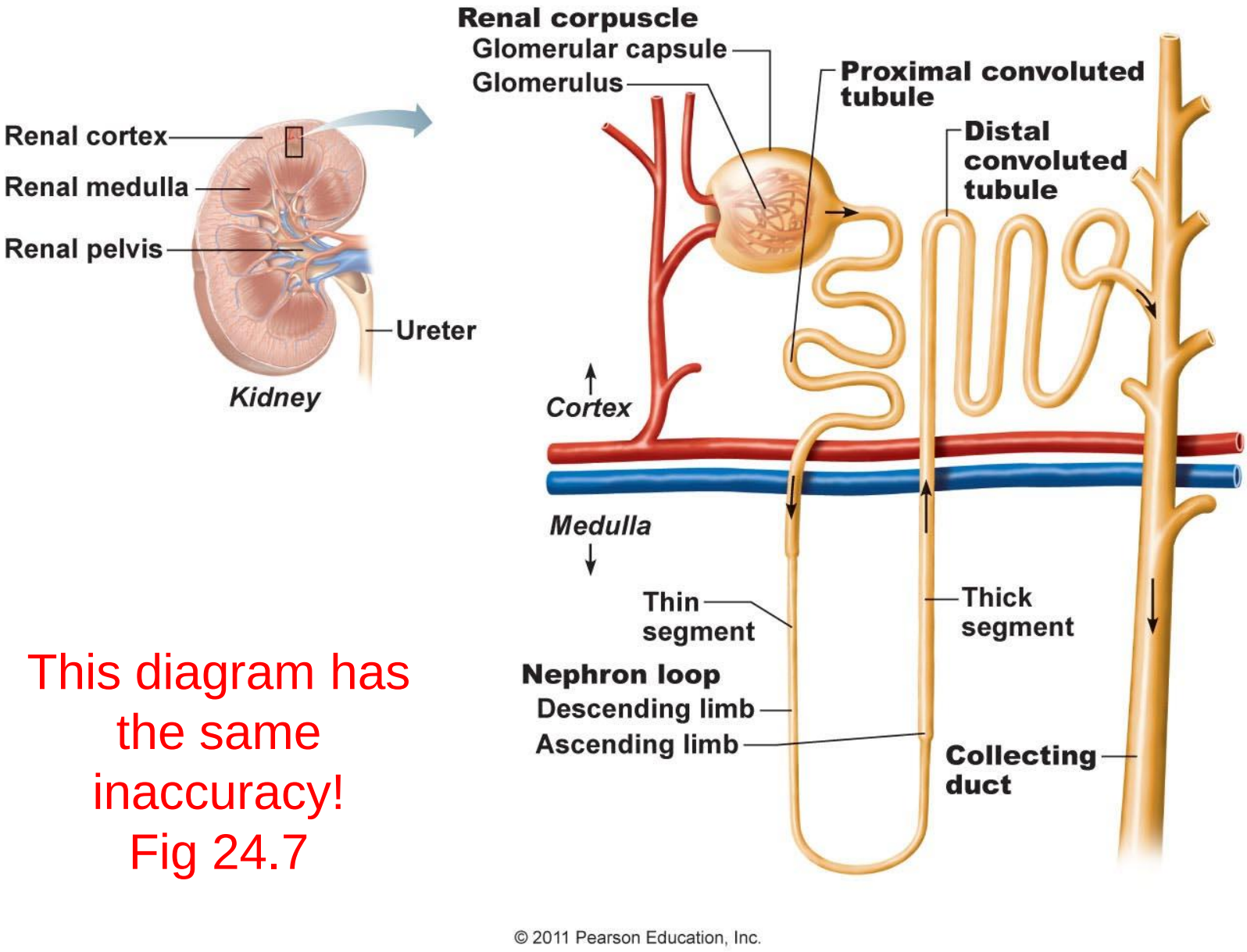


Blood Pressure

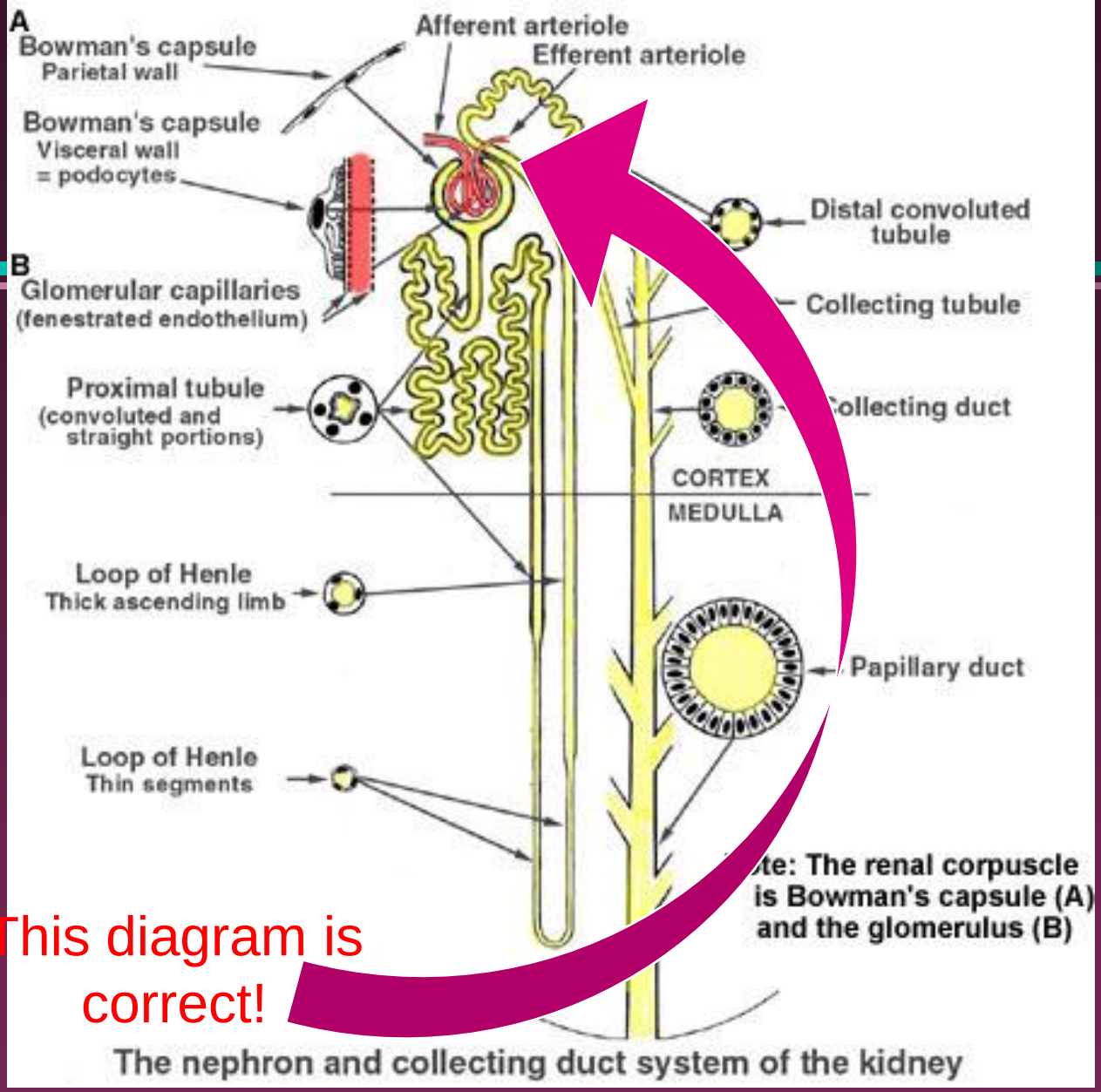




This diagram has an important inaccuracy!



This diagram has the same inaccuracy!
Fig 24.7

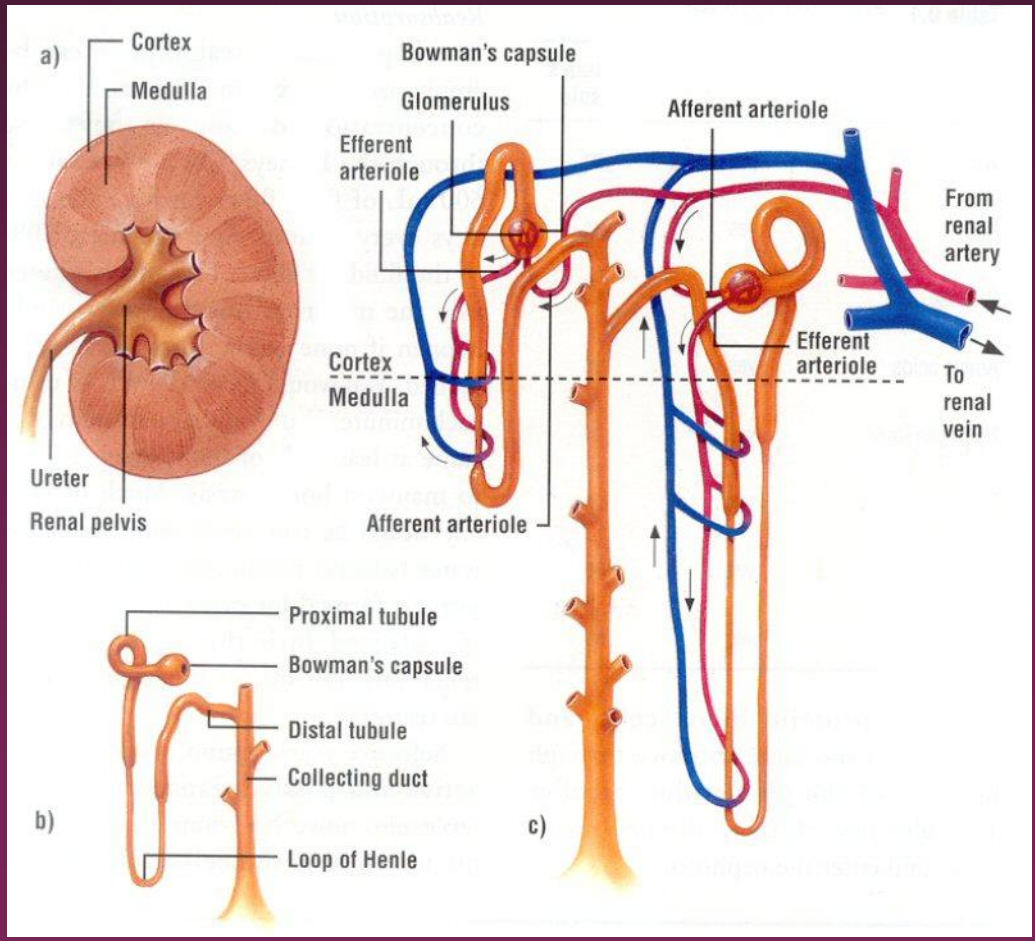


The DCT passes by the afferent and efferent arterioles to form the JG apparatus

Two Types of Nephrons

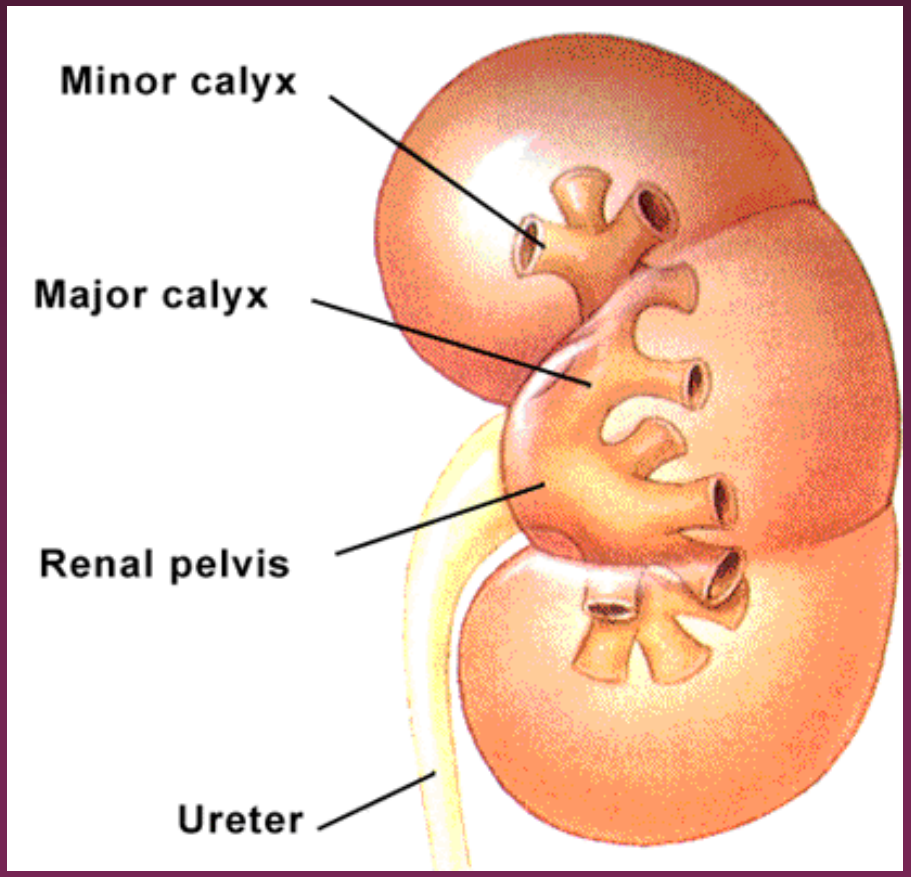
Fig 24.9

- Cortical nephrons (85%) shorter, mostly in cortex of kidney, produce "standard" urine
- Juxtamedullary nephrons (15%), "juxta = next to" the medulla - responsive to ADH, can produce concentrated urine due to longer Loops of Henle



Urine collection:

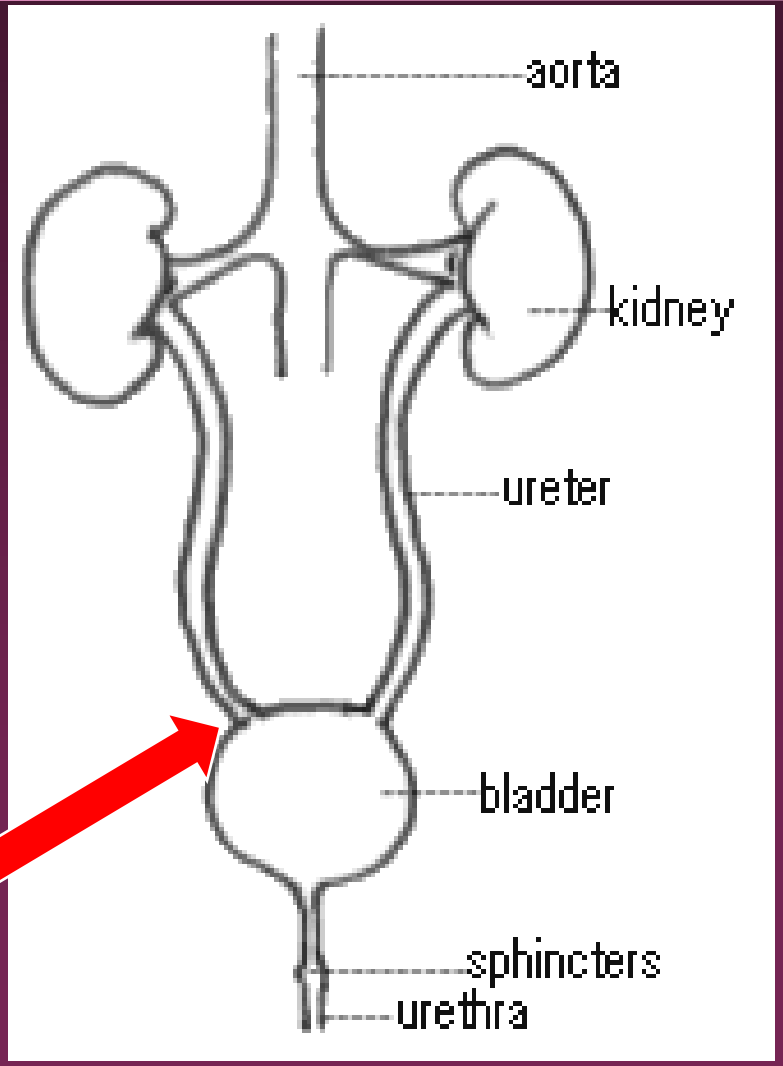
Collecting ducts within each renal papilla release urine into minor calyx → major calyx → renal pelvis → ureter



Ureters

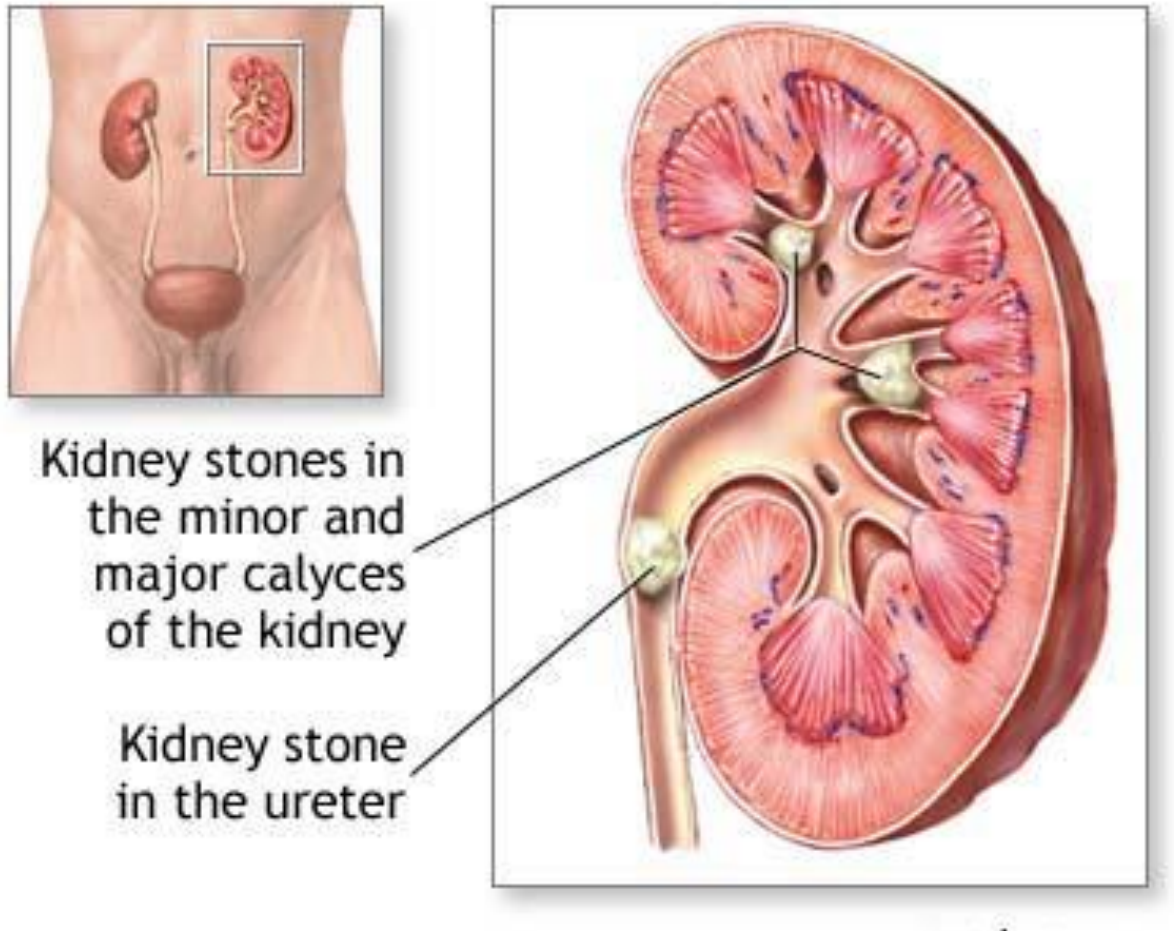
- From kidney to bladder
- Enter the posterior bladder at an angle
  - » Trigone
- Retroperitoneal
- Transitional Epithelium
- Nephroliths

This is another inaccuracy!!



Nephrolithiasis (kidney stones)

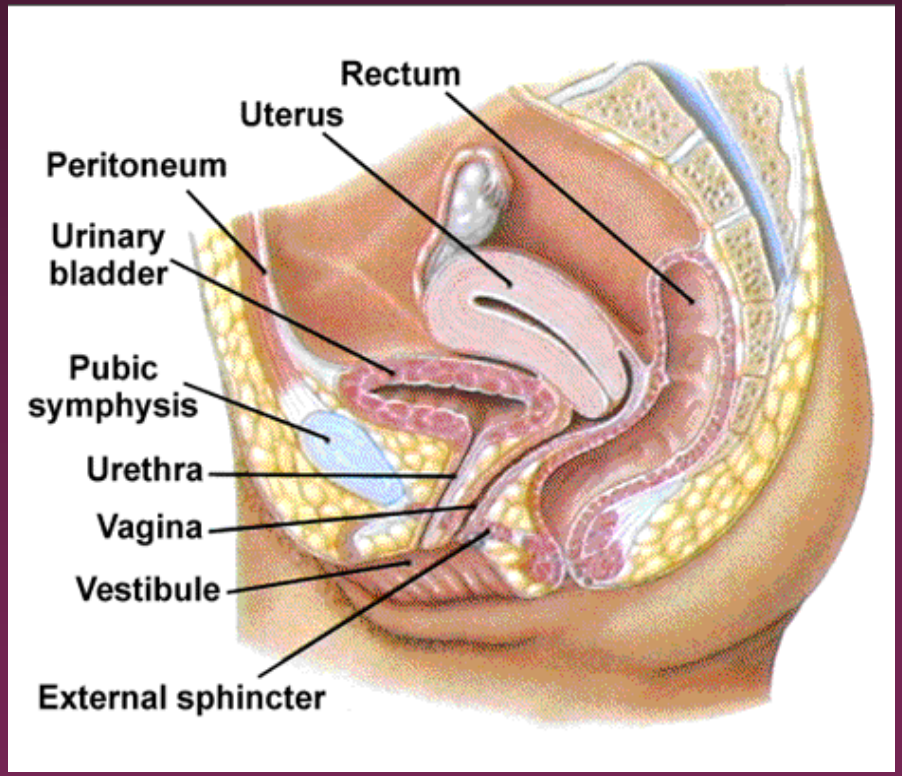
Occurs when urine becomes too concentrated and substances crystallize. Symptoms arise when stones begin to move down ureter causing intense pain.



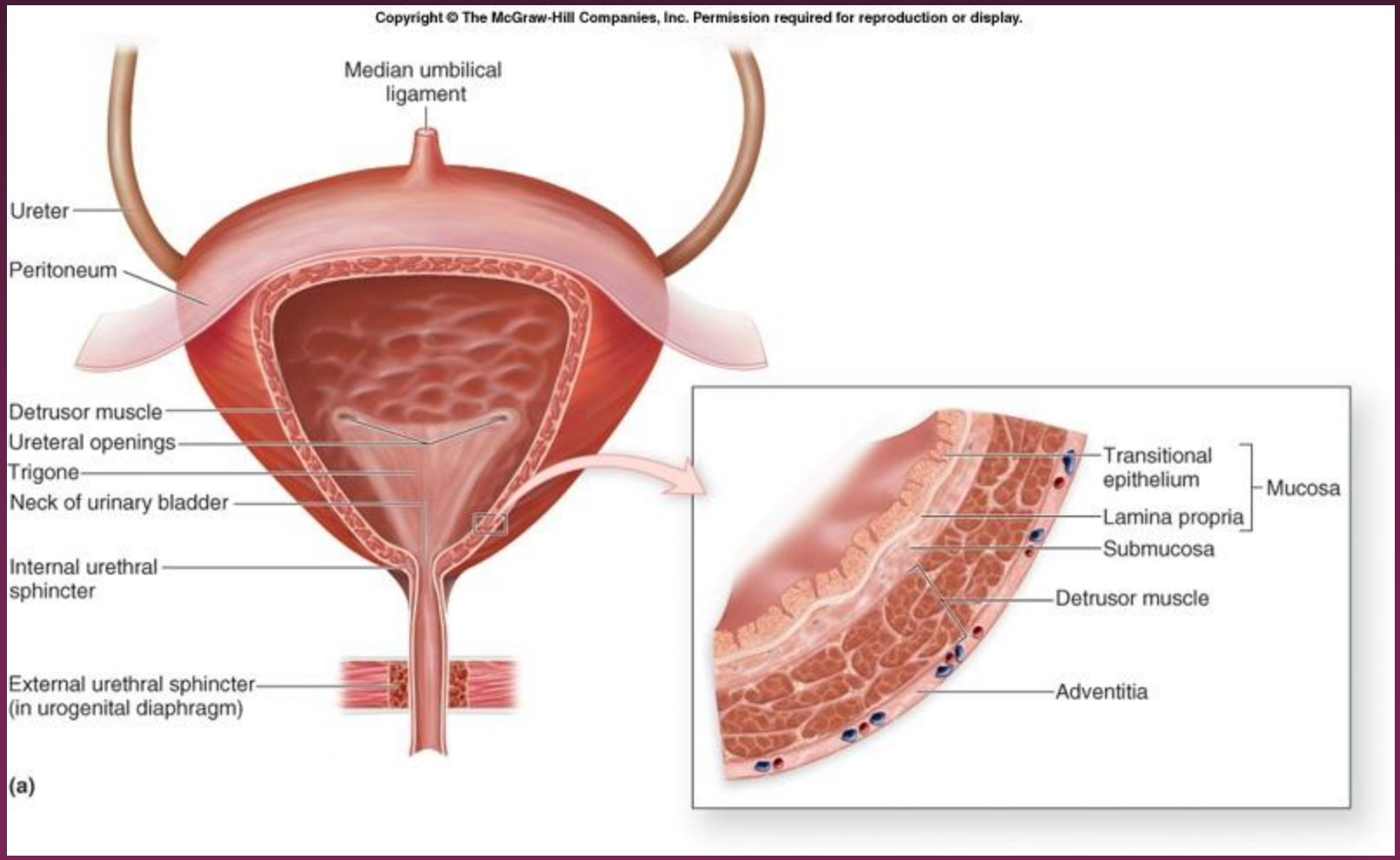
Kidney stones may form in the pelvis, calyces, or in the ureter. (Rarely in the bladder.)

Urinary Bladder

- Retroperitoneal, behind pubis
- Internal folds - rugae - permit expansion (max. holding capacity ~ 1L)
- Trigone - area at base delineated by openings of ureters and urethra - without muscle
- Internal urethral sphincter - involuntary sphincter

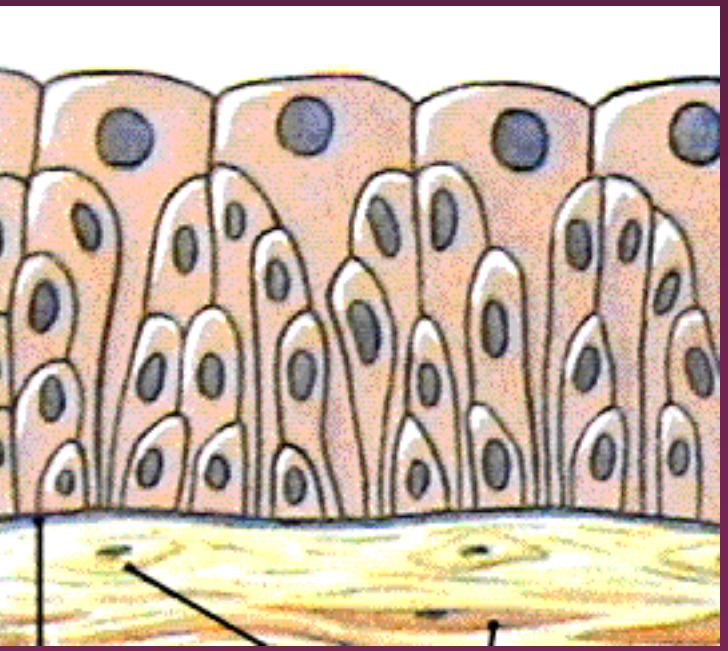


Urinary Bladder



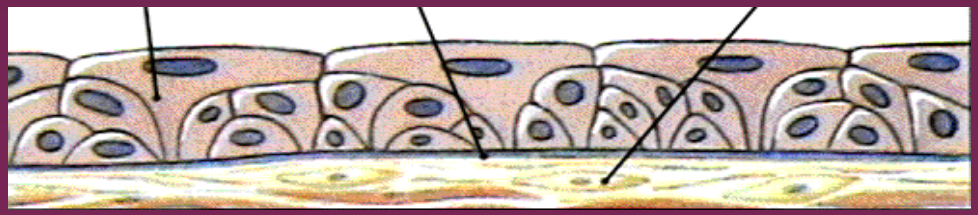
Urinary Bladder Histology

1. transitional epithelium from renal pelvis to neck of urethra.
2. detrusor muscle – smooth muscle



empty bladder

full bladder

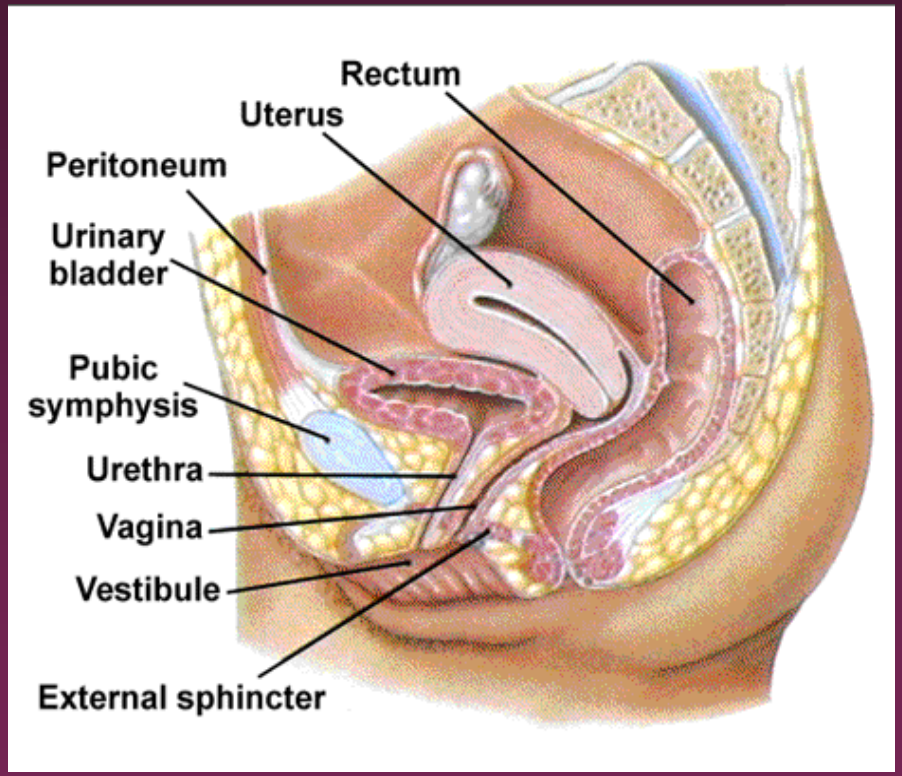


Urethra, Female

External urethral sphincter – voluntary at pelvic floor

3-5 cm – from base of bladder to vestibule

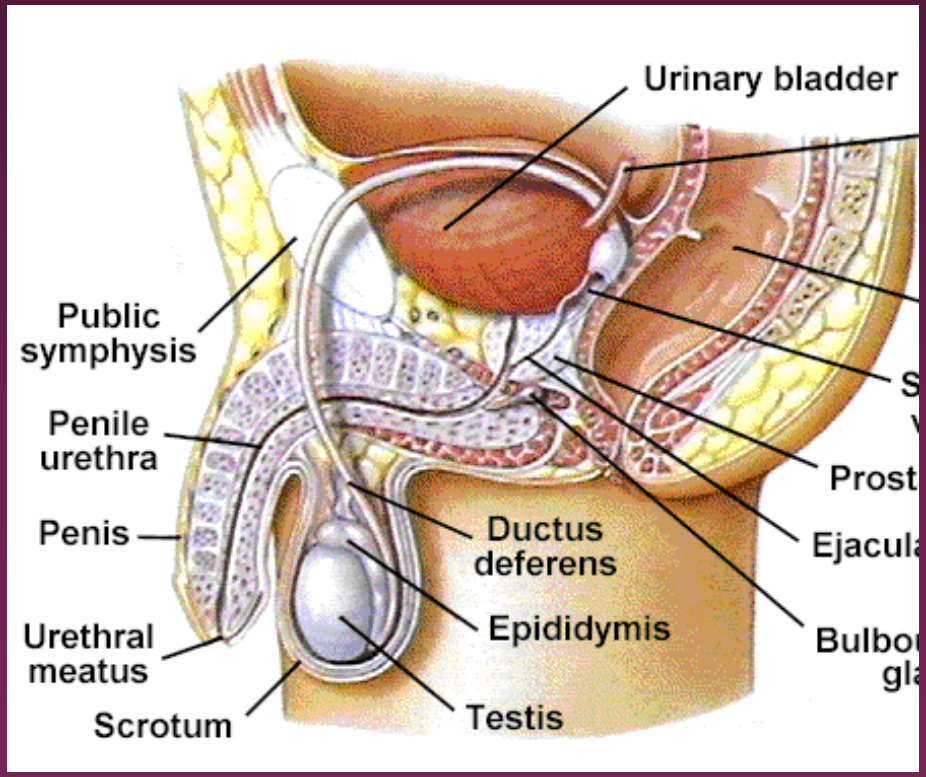
UTIs (esp. *E.coli*)



Urethra, Male

Male – 18-20 cm

1. prostatic urethra – from base of bladder through prostate gland
2. membranous urethra – between prostate gland & base of penis
3. penile (spongy) urethra – traverses penis to orifice



Male vs. Female

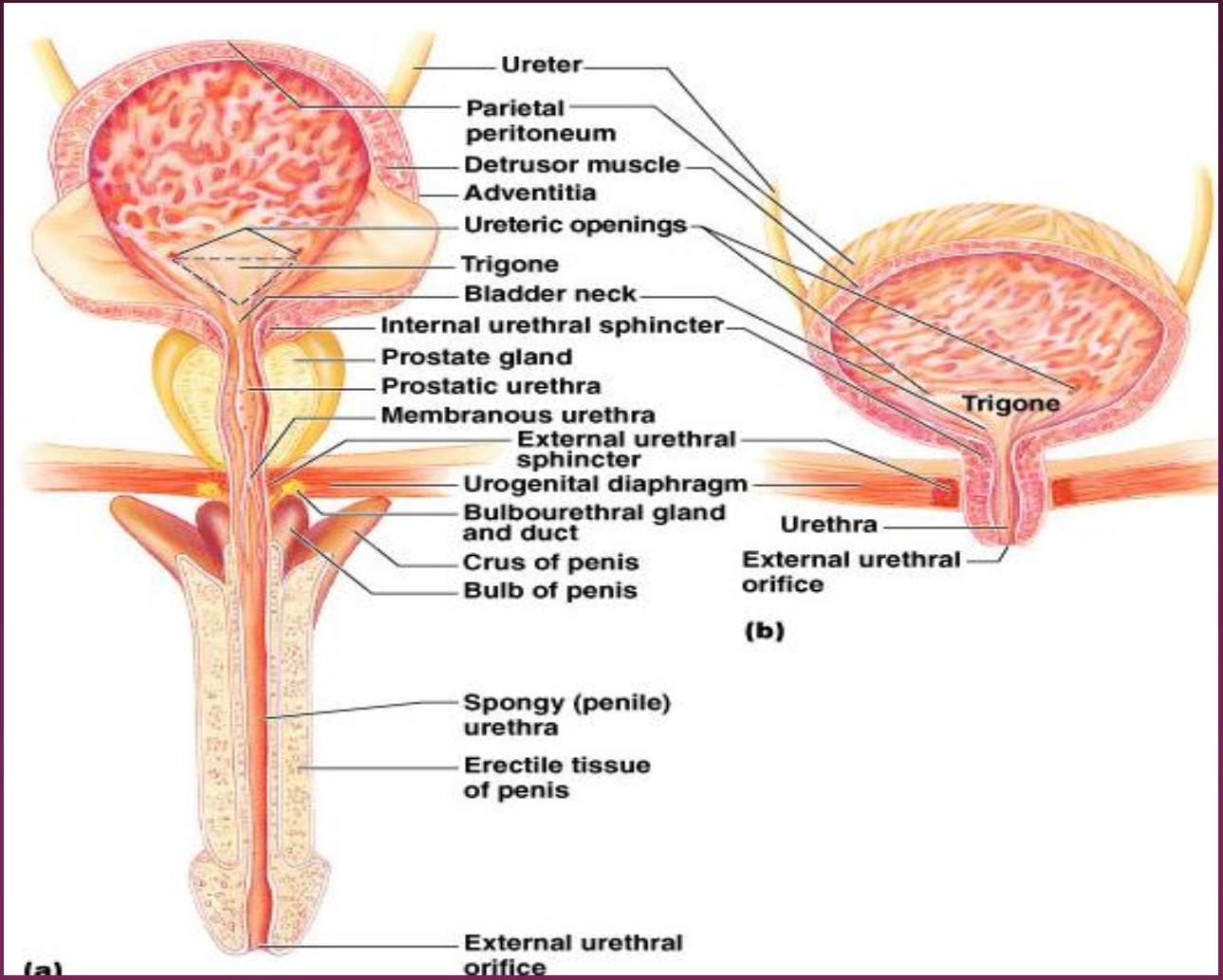


Fig 24.15

A drop of filtrate

1. Blood in the afferent arteriole goes to
2. Glomerular capillaries
3. Podocytes
4. Bowman's Space
5. PCT
6. LOH
7. DCT
7. Collecting Duct
8. Minor calyx
9. Major calyx
10. Renal Pelvis
11. Ureter
12. Urinary Bladder
13. Urethra
    1. Prostatic, membranous and penile in male

Manneken Pis Fountain

Brussels, 1619

- Kidneys may sustain 90% loss of nephrons and still not show apparent symptoms!!!
- 1/750 of population only have 1 kidney**!**